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Fact Sheet

Swine Housing

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The Environment in Swine Housing

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Trends to year-round farrowing and some confinement of the whole herd changed swine environments along with accommodations. The pigs have adapted fairly well, but new problems have come up. Environmental management is a critical element of time-intensive, space-intensive pork production systems.

Some argue that the modest improvement in swine performance in recent decades—despite marked enhancements in diet and genetic makeup—is due to unspecified adverse effects of the environments provided for the animals. All agree that housing is high on the list of pork industry problems.

The pig's environment is extremely complicated, and present knowledge of it and its effects on pig performance is relatively limited. There are, as yet, no pat remedies for environmental ills in swine houses. Thus, in environmental management we still must resort to knowing principles and how to integrate and apply them.

Further, each facility presents a unique set of surroundings. Each environmental problem must be considered in detail and in a way that accounts for all relations among its many parts.

Focus of environmental management: the pigs

The pig quickly responds to environmental stresses to survive and reproduce in adverse surroundings. These adaptations take the form of changes in body functions, structures and behavior.

Unfortunately, the pig's adaptive responses are often counter-productive in terms of swine performance. Some depress processes associated with growth, reproduction or lactation. Others impair disease resistance. All waste nutrients and lead to stragglers.

The pig must counteract specifically the particular stresses present, but its initial reaction to any stress includes a nonspecific component—increased secretion of glucocorticoids by the adrenal glands. These hormones in high concentrations support the animal's short-term survival, but they also mobilize amino acids from precious muscle proteins and interfere with some mechanisms of immunity against infectious diseases.

Minimizing environmental stresses is a key to profitable pig performance.

Assessing swine environments

While the swine-house environment is complex, most of its elements can be measured. Interpreting results of such measurements in terms of what they mean to pig well-being, facility operation and pork production economics remains a dilemma. This is largely because environmental factors interact with one another: the effect of one stressful factor on the pig depends very much on the nature of the rest of the environment. For example, a draft is more harmful in a cold, wet place than in a warm, dry one.

Advances have been made as experience has been gained in recent years. But often the troubleshooter still must engage in trial and error to identify the problem. Following are some points to be considered when assessing swine environments.

Consider all environmental factors. Environment results from all external conditions the pig experiences. Elements that cannot be readily measured or controlled influence the pig's health and performance, too, so even these should be considered so far as possible.

Remember interactions. The environmental complex acts as a whole on the pig. Combined effects of two or more environmental components are often difficult to evaluate and control, but nonetheless they should be considered.

Environmental factors vary over space at a given time. Values obtained at one place in a pen or house may not hold for other locations. It is important to measure environmental variables where the pig experiences them—in its microenvironment.

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They also change with time at a given place. A swine facility may be occupied continuously. Because environmental factors and occupancy vary with time, needed control measures do, too. This is especially so when days are warm and nights are cool. Environmental assessments and control schemes should take daily and seasonal environmental cycles and variations due to short-term weather events into account. Of course, the pig readily adjusts to environmental cycles as long as the extremes are not unduly stressful.

Rate of environmental change is critical. Abrupt environmental changes tend to be more stressful than changes occurring over a longer period. For example, preconditioning young pigs to a cool environment before moving them from an enclosed nursery to an open-front house during cold weather reduces stress.

Pigs modify their own environments. Pigs give off heat, water vapor, urine and feces, and shed disease-causing organisms. Thus, the animals' own processes help determine the nature of their microenvironment. Changes in age or number of pigs in a facility alter animal impacts, and, therefore, the control measures required.

Beware. There is a tendency to assume that if a human is comfortable in a certain environment, a pig would be, also. Beware of this pitfall. Pigs may be more or less sensitive to a certain stressor than are humans. Manage swine-house environments with the pigs' needs in mind.

Thermal environment

The pig regulates its body temperature by balancing heat loss against metabolic heat and heat gain. As the difference between body and environmental temperatures becomes greater, heat-loss rate increases.

Effective environmental temperature. The environment's demand of heat from the pig is determined largely by air temperature, radiant-environmental (wall and ceiling) temperatures, air speed and floor characteristics. Take 80-lb. pigs, for example (the principles hold as well for swine at other stages of life). In a house with walls and ceiling 5 F. cooler than the air and a 1 ft./sec. draft across the animals, effective temperature is 15 F. lower than air temperature. If these pigs are on a concrete-slat floor, effective temperature drops another 10 F., but with straw bedding the adjustment is +7 F.

Lower critical temperature. Body size, thermal insulation, feed-intake rate and group size determine the effective temperature below which pigs must increase heat-production rate to keep their bodies warm. Considering 80-lb. pigs again, when consuming 3.2 lb. of feed daily in a group of four, lower critical temperature is 63 F.; when taking in 4 lb. daily and in a group of nine, it is 50 F. Similarly, for early-pregnant sows consuming 3.7 or 7.7 lb. of feed daily, lower critical temperature is 75 or 65 F., respectively. By late pregnancy it has dropped 10 F. in both cases.

Feed or fuel? During cold weather, the manager may (1) raise environmental temperature to reduce environmental heat demand, (2) increase the pig's heat gain by means such as a radiant heater, or (3) let the pig raise its metabolic rate to produce more heat itself. The first two options require fuel or power, the third feed.

How much extra feed is required to keep the body warm? Again referring to an 80-lb. pig, for example, when effective environmental temperature is 20 F. below the pig's lower critical temperature, the pig would need to consume around ¼ lb. additional feed daily just to keep body temperature normal. The dry sow's feed allowance should be increased when environmental temperature falls below 70 F.; at 50 F., for example, the sow should receive an extra 1½ lb. daily.

"Humidity." The pig relies less on evaporative heat loss than many species do, so high vapor pressure, which supresses evaporation, is less critical for swine. Vapor pressure has little influence on the well-being or performance of swine unless air temperature exceeds 90 F. Moisture control is nonetheless necessary in swine houses as damp surroundings favor both survival of pathogens and structural deterioration of the building.

Air distribution. Effective ventilation depends on uniform air distribution in a swine house. Drafts may cold-stress the animals, while stagnant areas may lead to heat stress. Thus, knowledge of air-flow patterns is essential to an understanding of the pigs' thermal environment.

Regardless of whether natural or mechanical ventilation is employed, air flows as it does inside an animal house largely because of its density as it comes in. Warm air entering through an inlet under the eave or in the ceiling is buoyant and tends to continue moving along the ceiling to the outlet. It mixes with house air before reaching the animals. But when incoming air is cooler and denser than house air, it tends to drop to pig level before mixing.

In many parts of the country, during the seasons of change, incoming air is "warm" during the day, but "cool" at night. On such days, primary and secondary air-flow patterns within the house change twice daily. As this reversal occurs on such an evening, the pigs may experience some rather sudden environmental changes as air temperature drops and air speed rises.

Air-flow patterns in swine houses are controlled mainly by inlet position, assuming adequate fan capacity. Inlet-opening size influences the air's speed as it enters the house, and this, in turn, has a large effect on air distribution. Further, air may be directed to a certain extent by inlet baffles.

When an exhaust-fan system is used during winter, cracks and gaps in the building may become inlets for small jets of cold air. These airstreams may cold-stress nearby pigs.

Even in environments in which the air is normally still, application of radiant heat sets into motion convective eddies that partially erase any beneficial effect of the radiant heat itself. This is especially harmful when the draft so created carries to the pig cold air that has just dropped into the house from the outside.

The newborn piglet. The piglet's lower critical temperature is around 95 F. The piglet's total heat-loss rate is 2/3 higher in a 70 F. environment than in one at 85 F. Evaporation from skin and respiratory passages leads to less than 10% of its heat loss, regardless of effective environmental temperature. No more than 15% of the piglet's heat loss is to the floor, so floor temperature has relatively little effect on *total* heat balance. Nevertheless, heat loss rate to the floor is twice as great on concrete as on wood, for example.

The remaining 75% of the piglet's heat loss flows by either radiation or convection. Thus, environmental conditions that affect these flows are important determiners of the piglet's thermal comfort.

Wall and ceiling temperatures are major factors in radiant heat loss, whereas air temperature and speed largely influence convective heat loss. Dropping wall and ceiling temperatures by 20 F., even when air temperature remains the same, increases the piglet's total heat loss rate by around 20%, which emphasizes the need for a well insulated farrowing house.

Disease and environment

The environment exerts various influences on the incidence and severity of infectious diseases.

Environment and microbe challenge. Pathogenic agents—bacteria, viruses, spores, oocysts, worm eggs, and so on—reside in the environment as they pass from one pig to another. The nature of the surroundings determines how long they can challenge another pig.

The presence of organic matter and moisture and the limited sunlight in closed swine houses all favor survival of pathogenic forms. In general, cooler environments also enhance pathogen survival because they retard drying, the major cause of pathogen death outside the pig.

Air humidity affects the rate at which feces dry, and fecal bacteria die 10 times faster when relative humidity is 40% than when it is 80%, for example.

Slotted floors help separate the pig from the pathogens its feces contain. However, disease-causing bacteria may survive for months in underfloor waste, and may be aerosolized when the slurry is disturbed and be wafted by air currents back into the pig's microenvironment. Worm eggs also accumulate in wastewater, even when it flows into a lagoon, which can cause problems when wastewater is used to flush gutters.

The incidence of infectious disease increases the longer a house is occupied. "Disease build-up" can be checked by depopulation and disinfection. A recent trend has been to batteries of rooms in swine houses, each operated on the "all-in, all-out" principle instead of continuously. Some recommend no more than 200 pigs in one air space to make it easier to contain an acute disease outbreak.

Vectors of pathogenic agents pose a special problem; they usually give no clue to their role. Many microbic diseases of swine can be spread by wild birds and rodents, and even by barn cats. Humans commonly carry swine pathogens from place to place, and this can be reduced greatly by using footbaths or changing footwear and changing coveralls between areas and by not touching the animals themselves. The most effective vector, however, is the carrier pig. The premises may be immaculate otherwise, but if a carrier is present, all efforts in disease management are in vain. On the other hand, the origin of a pathogen may be exotic. For example, sawdust may be contaminated with bacteria that cause mastitis.

The manager decides the level of sanitation largely on the basis of history. When overt disease has been absent, a thorough dry and wet cleaning after the house or pen is emptied may suffice. But some have come to prefer a routine program of terminal cleaning and disinfection.

Environment and pig resistance. Intestinal and respiratory maladies of swine often result from infections by opportunistic pathogens. Under usual circumstances, the pig's defenses control these infections to the point that disease does not follow. But stress may reduce the animal's resistance, and disease blooms.

As discussed earlier, glucocorticoid secretion rate rises during the initial phase of an animal's nonspecific reaction to any stress. While these hormones at lower levels in the blood support defense mechanisms, at high concentration they impair resistance by interfering with antibody formation, reducing counts of certain white blood cells, hampering detoxification mechanisms and depressing microbic-clearance processes.

Air environment

The pig's respiratory tract is in intimate contact with the air and consequently, in closed houses, with air pollutants. Those of major concern include microbes, dust, and gases and odorous vapors, all arising from the pigs and their activities. Air pollutants may affect pig performance directly by altering metabolic reactions or indirectly by influencing pig health. Caretakers may also be affected.

Bacteria. Concentration of airborne bacterial particles in a closed swine house ranges from around 500/cu. ft. during warm weather up to around 10,000 during cold weather, the variation being due mainly to ventilation. In modified-open-front houses, the range is lower, 100 to 5,000/cu. ft., but still considerably higher than the 10/cu. ft. found in outdoor air. Vapor pressure and airborne bacterial concentration are generally related inversely; moister, heavier particles settle faster.

Most of the airborne bacteria in swine houses are staphylococci or fecal streptococci; coliforms are scarce. Roughly 20% of the staph and strep particles and 10% of the coliforms are small enough to be drawn all the way into the lungs. In addition to bacteria that arise from the pigs' skin and excreta, respiratory pathogens may also be present in air. Each sneeze aerosolizes about 40,000 microbe-laden droplets.

The pig normally can clear bacteria and keep its lungs relatively sterile. However, cold exposure and other stresses depress this process, predisposing the pig to respiratory infections.

Dust. Most of the dust in swine-house air originates in the feed. When ventilation rate is low, dust concentration in many swine houses approaches the threshold-limit value for human industrial occupancy of 0.3 mg./cu. ft. But even at this concentration, airborne dust has little direct influence on the pig's growth.

Gases and odorous vapors. Swine-house air is polluted by several dozen fixed gases and odorous vapors given off as manure decomposes. The most important of these, related to pig health and performance, are hydrogen sulfide and ammonia. At concentrations normally present in closed swine houses (less than 10 ppm), pigs tolerate hydrogen sulfide well. But when underfloor waste is agitated prior to removal, hydrogen-sulfide concentration above the floor can reach over 1,000 ppm—lethal to humans as well as pigs.

Ammonia is present in swine-house air at concentrations up to 100 ppm. At 50 ppm, atmospheric ammonia hinders the young pig's ability to clear bacteria from the lungs. It depresses growth in healthy young pigs when it exceeds 75 ppm.

Control measures. Control of air pollution can aim at prevention or elimination. Prevention centers on waste management and feed distribution. Biological and chemical preparations for odor control in swine houses may be beneficial in some cases.

Eliminating air pollutants depends mainly on dilution by ventilation. In addition, electrostatic precipitation can be used to reduce atmospheric concentrations of dust particles and the microbes and irritating chemicals they carry.

"Threshold sanitary ventilation rate" is the air-change rate that eliminates airborne transmission of infectious agents. It is much higher than economically feasible in swine houses. For both airborne bacteria and viruses, the higher the air temperature, the more quickly they die. As for vapor pressure, the viruses vary greatly in their susceptibility range, whereas midrange relative humidities, 50-80%, are most lethal to airborne bacteria. Air may also be disinfected when pigs are in the house.

Ultraviolet radiation, from the sun or a generator, kills microbes that it reaches, but airborne pathogens in swine houses are often coated with a protective layer of feces or mucus.

Behavior and environment

Behavioral maladjustments are often at the root of unthriftiness that shows up as stragglers.

Dominance order. Pigs grouped together organize themselves in a dominance order according to the outcome of fights during the first few days after grouping. The resulting social stability is an advantage, as little energy is further spent in combat and injuries are minimized. But there are drawbacks, too. Competition for feed spurs intake somewhat but much of the variation in growth among pigs is due to dominance-order rank. Under poor husbandry, especially when access to feed is marginal, the connection is more marked.

Group size and space allowance. Pig growth is not influenced by group size up to at least 40. But the dominance order seems less able to control aggression when space allowance is reduced. At low space allowance, pigs are more active and aggressive, which agrees with the sizeable effects space allowance has on growth and feed-conversion efficiency.

Mixing. The fights that result when strange pigs are grouped have little direct effect on growth, but they may reduce disease resistance or cause injury, and thus affect growth indirectly. Pigs should be mixed in a pen that is new to all; they may become extremely aggressive against intruders on home territory.

Frustration. In confinement environments, movement is restrained, the environment is monotonous, and the pig has scant chance to choose or alter its microenvironment. For example, the sow kept in a crate prior to farrowing cannot fulfill her strong instinct to build a nest, and this interference may contribute to farrowing and lactation problems. Tethering gilts before puberty also has untoward consequences; the reproductive tracts of many of them never mature.

Pigs prefer comfortable surroundings, and they learn to operate devices that provide reward, such as a waterer. There is scope for training pigs to operate more control over their own environments. This may also reduce frustration.

Reproduction. The social environment young boars and gilts are kept in influences their reproductive function and behavior. Much sexual behavior is learned around the time of puberty. Young boars in homosexual, uniform-age groups cannot gain heterosexual experience when they are ready to learn, at 4 to 8 months of age. Often failure to "get boars to work" is due to lack of such social experience.

Gilts raised in confinement frequently reach puberty late or not at all. Sometimes a move outdoors triggers estrus. Group size is a factor, too. Gilts in groups of around 6 show heat more readily than those in larger groups, regardless of space allowance. Solid partitions between groups help, too. Keeping a boar near gilts also supports their reproductive development.

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